Chapter 1

1 What is internet?

a. "A nuts and bolts" view:

↳ Computer network that interconnects hundreds of millions of computing

b. "A service description" view

↳ The infrastructure that provide application services which include (web, social network, video streaming, instant messaging, distributed games...)

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* Mention main components of Computer network:

a) millions of Connected Computing devices

hosts = end systems • running network apps.

b) Communication links (media)

• wire (fiber, copper) • wirless (radio, satellite)

c) InterConnected ISPs (internet service Providers)

d) Protocol control (send and receive data)

e) internet standards

RCP → request for Comments

IETF → internet engineering task force.

Note

API ⇒ Application Programming interface

↳ allow sending and receiving app. programs.

*what is Protocol?

↳ It defines format, order of messages sent and received among network entities, and actions taken on message transmission

*Network Edge: we look at edge network and components

end systems: = host

→ desktop computers (PC, linux boxes, Macs)

→ servers (web, e-mail servers)

→ mobile computer (tablets, smartphones)

hosts ⇒ client + servers

*Access networks

→ edge router

↳ first router in home network and between core network and edge network.

Core network → network contains on packet switching

→ DSL (digital subscribing line)

↳ takes digital data and translates it to high frequency tones for transmission over telephone wires to central office, analog signals from many houses are translated back into digital format at the DSLAM.

Notes

→ data over DSL phone line goes to internet.

⇒ voice " " " " " " telephone net.

⇒ residential telephone line carries both data and traditional " signals together, which are encoded at different frequencies:

a) high-speed downstream channel 50 KHz ... 1 MHz

b) A medium- " upstream channel, 4 KHz ... 50 KHz

c) ordinary two-way telephone " " 0 ... 4 KHz

* Frequency division multiplexing: different channels transmitted in different frequency bands.

DSL standards → upstream 2.5 Mbps
→ down stream 24 Mbps

* HFC (Hybrid fiber coax) → fiber and coax working in system.

* CMTS (cable modem termination system)
→ up stream 2 Mbps
→ down " 30 Mbps

→ It divides HFC to two channels (up stream, down stream), doesn't has the right to reach to central office.

*Home network (Ethernet)

↳ It is used usually in Companies, universities, ...

→ end system connected with Ethernet switch.

*wireless LANS → Cover area of 100ft.

→ IEEE 802.11 b/g (wifi) uses this technology.

*Wide-area wireless access

→ Covers 10 Km. → speed between 1 Mbps, 10 Mbps.

→ Contains technologies like (3G, 4G, LTE)

→ Speed rate reach 1 Mega, it may reach 10 Mbps in 4th generation.

*Physical Media (links between media)

→ HFC uses Combination of fiber, Coaxial.

→ DSL, Ethernet use Copper wire.

→ mobile access uses radio spectrum.

Bit Propagates between transmitter/receiver Pairs

Physical media

Guided media
bits تنتقل
solid media داخل

unguided media
bits تنتشر في الفراغ المحيط باستخدام signals كموجات (radio-satelite) channel

1) Guided media :-

a. twisted pair copper
↳ used to prevent the electrical intervention

b. Coaxial Cable
↳ make us send and recieve

c) fiber-optic Cable
↳ glass fiber carrying light pulses, enormous speeds.

2) unguided media → Propagates across air and space.

→ no wire, bidirectional
→ signal Carried in electromagnetic spectrum.

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* What is network Core?

→ mesh of interconnected routers or mesh of Packet switches and links that interconnects internet's end systems.

Transform data → Packet switching
→ circuit switching

Packet switching → Packets move between group of routers.

To send message from source end system to denstination end sys., source breaks long msgs into smaller chunks of data called Packets.

Store and Forward transmission

L means that Packet switch must receive the entire Packet before it can begin to transmit first bit of Packet onto outbound link.

* $d_{end-to-end} = N \frac{L}{R}$ ← delay

N → no. of links / Packets

L → bits per Packet.

R → rate of transmission.

queueing delay

~~2nd delay~~

Packet loss

← جزء الـ (data) الموجودة في الـ (Packet) بعد الـ (bits) الزائدة drop

* Queueing delay, loss

→ queue of Packets wait for output link

→ Packets is arriving and may found that buffer is completely full with other Packets waiting for transmission, Packet loss will occur or one of already-queued Packets will be dropping.

What is forwarding? move Packets from router's input to appropriate router output.

What is routing?

L determines source-destination route taken by Packets.

2 Circuit switching → packets move between 2 end of switches.

→ every link Contains 4 circuits.

→ dedicated ~~source~~ resources.

→ Circuit segment idle if not used by Call.

⇒ FDM → Frequency-division multiplexing.

Frequency divided to several frequencies and every user send on his private frequency.

TDM (time division Multiplexing)

↳ time is divided and every user uses his time to send in same frequency.

Packet switching	Circuit switching
resources are not reserved	reser~~er~~ources are reserved ~~during~~ during
~~is~~ used on demand	for duration of Communication Session between end systems.
more users use network	to users

Advantage of Packet?

1) offer better sharing.

2) simpler, more efficient and less Cost.

* Network of networks

End systems connect to internet via ISPs.

→ resulting network of networks is very complex.

* delay, loss, throughput in networks

i) Delay d_{noded}

$$d_{noded} = d_{proc} + d_{queue} + d_{trans.} + d_{prop}$$

a) d_{proc} : (nodal processing)

→ check bit errors. → determine output link.

→ typically < msec.

b) d_{queue} : (queuing delay)

→ time waiting at o/p link for transmission.

→ depends on congestion level of router

c) d_{trans} (transmission delay)

↳ lost time in passing the packet.

$$d_{trans}^{(s)} = \frac{L\ (bits)}{R\ (bps)}$$

L → Packet length

R → link bandwidth.

→ depend on type of link.

d) d_{prop} (Propagation delay)

↳ time of spreading of bits in Communication link.

→ depend on speed, distance between 2 routers or

Propagation of bits in transmission media.

$$d_{prop}(s) = \frac{d\,(m)}{s\,(m/s)}$$

d → length of physical link

s → Propagation speed in medium (2×10^8 m/s)

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* Packet loss ← فقدان (Packet) من ال (Queue) نتيجة امتلاء ال (Queue)

↳ lost packet may be transmitted by previous node, or source end system or not at all.

* What is traceroute program

↳ simple program that can run in any internet host to provides delay measurment from S to D.

Throughput in Computer networks

↳ rate of which bits transferred between sender and receiver.

RS → rate of link between server / router.

RC → " " " " router / client.

min route packet → المتحكم الأساسي في هو

R_s, R_c

1) $R_s < R_c$

→ bits pumped by server will flow ~~right~~ through router and arrive at client at rate R_s bps, giving throughput of R_s bps.

2) $R_c < R_s$

↳ router will not be able to forward bits as quickly as it receives them.
So bits will leave router at rate R_c, giving end-to-end throughput of R_c

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* Protocal layring

↳ every sender and receiver contains half of number of layers, every layer has operations and divided by part to sender and another to receiver.

* Application layer

↳ responsible for Apps. that existed on end-systems and data that is called message.

→ every app has Protocol makes it work and consists of messages.
HTTP → open website } FTP → open mail.

* Transport layer

↳ responsible for determining way of transforming the message.

TCP: Connection oriented, define Path and way to transform data.

UDP: Connection less, don't Carre for Path or way.

* Network layer:

↳ organize the operation of sending data on network on the way of choosing the Proper Path of data.

IP Protocol: define address of end-system that we deal with.

* link layer

↳ makes the frame (some of datagrams together and we put address on them then sent to Physical layer)

* Physical layer

↳ take the frame and breaks it to series of bits and send it bit-by-bit to pass through wires.

Layers

[1] Internet-Protocol Stack

- send (end sys) : (application, transport)
- router (network, link, physical)
- switch (link, physical)

[2] Iso OSI reference model

all layers in [1] in addition to Presentation Layer & Session Layer

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* Presentation layer:
  - to compress and encrypt data then merged with application layer
* Session layer
  - check on data to make sure that it is correct.

Network security

* field of network security
  - How bad guys attack on computer network.
  - defense-strategy on this attacks.
  - design- " • on this defense

قادر على التكاثر الذاتي
بمجرد دخوله الجهاز.

* malware can get in host from

1) virus : self-replicating infection by receiving / executing object.

2) worm self-replicating by passively receiving object that gets it self executed.

* spyware

↳ can record keystrockes, websites visited, upload info. to collection site.

برنامج يبلغ بيانات شخصية تخص كل (user) مستخدم (hosts) وتبعها لـ (attackers).

* DDos attaeks

↳ infected host can be enrolled in botnet used for span.

* Dos (denial of service)

↳ existence of one attacker to attack server is not effective.

* DDos (distributed Dos)

↳ existence of more than one attacker.

* Packet "sniffing"

↳ used to attack hosts by using group of Packets, its source address unknown.

* IP spoofing : send Packet with false source address.

BW حجم البيانات المسموح لل (end systems) استخدامها.

route → Path that packet takes from source to destination.

solution of Queuing delay

→ increase size of Queue

→ use checker on begining of Queue to manage its work, It passes important packets.

* Protocol stack

end system:
- → application
- → transport

router:
- → network
- → link
- → physical

switch:
- → link
- → physical